HALT/HASS for Pixel Modules

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Most Information and plots taken from Votsch Industrietechnik : HALT and HASS

What is HALT/HASS

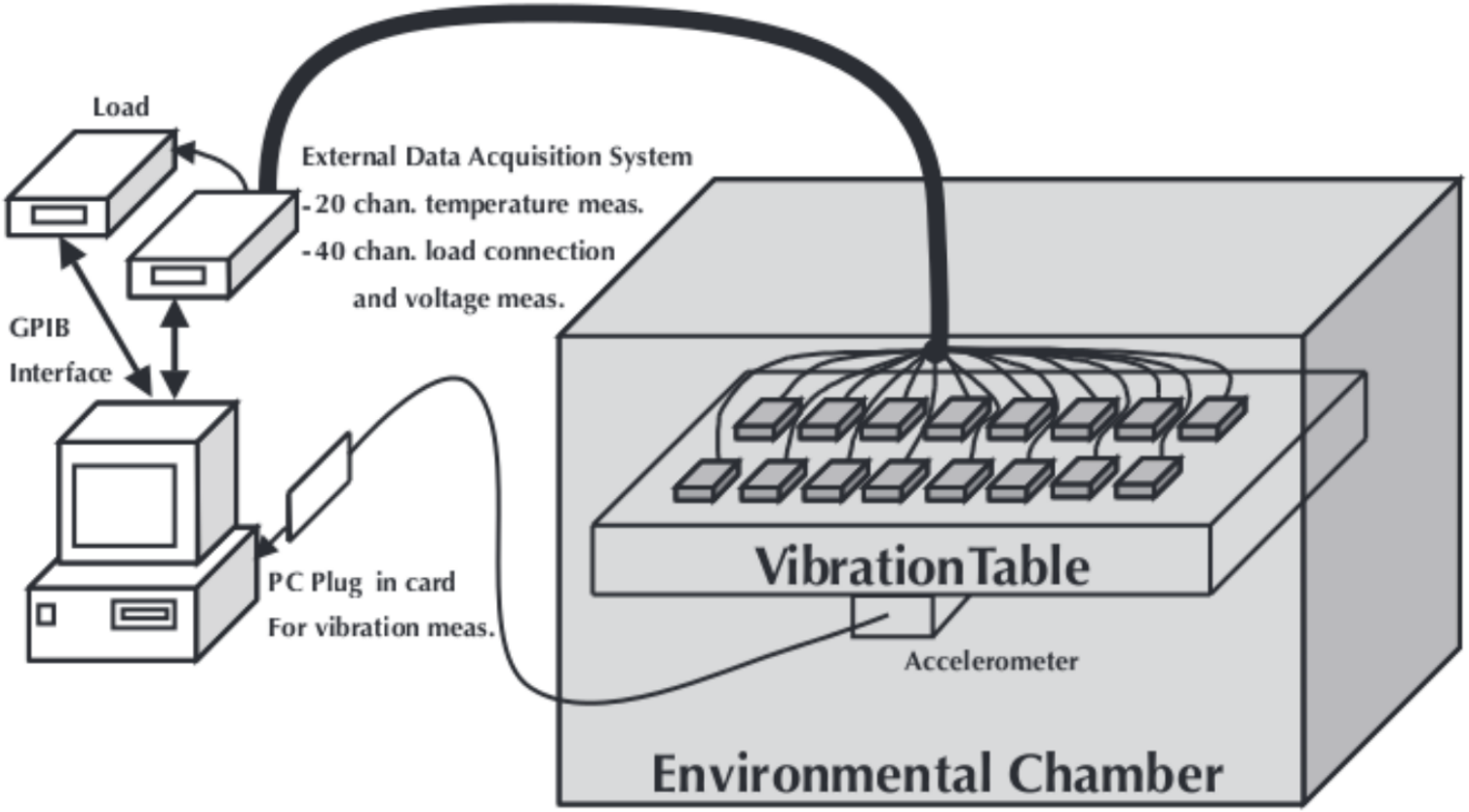
- HALT- Highly Accelerated Lifetime Testing
- HASS- Highly Accelerated Stress Screening

- HALT is a step by step stress process performed during a product's prototype phase that determines a product's operating limits, identifies design weaknesses and identifies problems with components

HALT

- A test sample is subjected to progressively higher stress levels
  - Thermal steps
  - Rapid temperature changes (Thermal Shock)
  - Vibration
  - Combination of Vibration and Thermal
- Goal is to find latent, inherent defects in the design at both the component level and in the manufacturing process

Typical HALT/HASS system



Plot from Fundamentals of HALT/HASS
Testing: Keithley

HALT

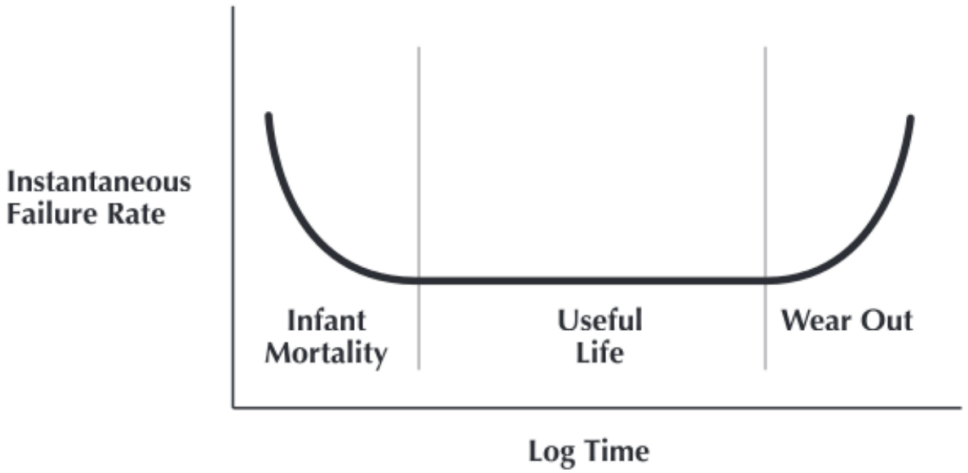
- Beyond finding defects, HALT stresses product to failure
- Robustness of design and margin above products intended operating level are determined.
- HALT is not a pass/fail test
- It is a process of understanding the products limitations and design optimization

HALT

- Successful when failures produced, cause is understood, corrections are implemented and product's limits are understood and expanded
- Information learned during HALT process is used to develop HASS screening for monitoring issues in the manufacturing process.

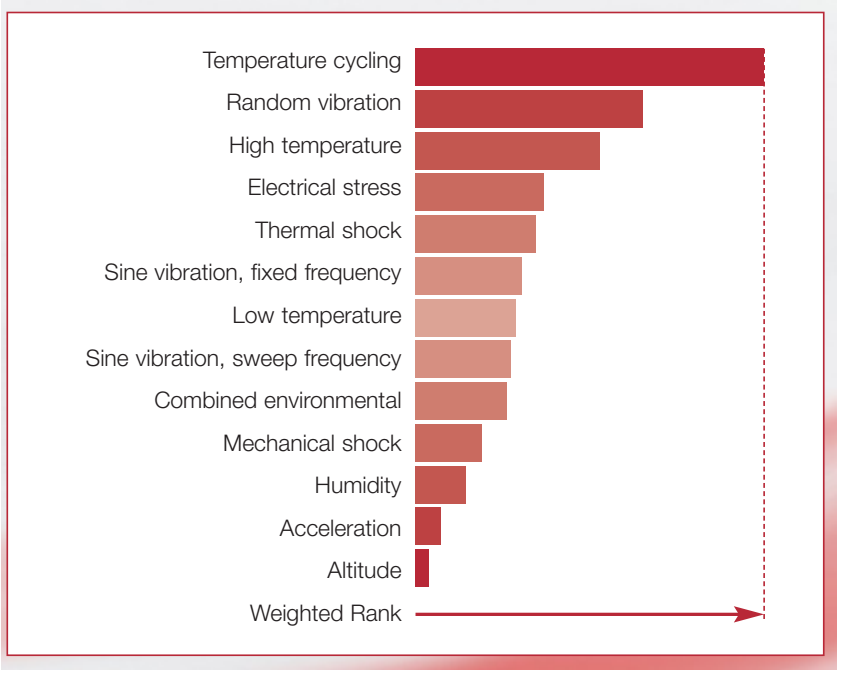
HALT

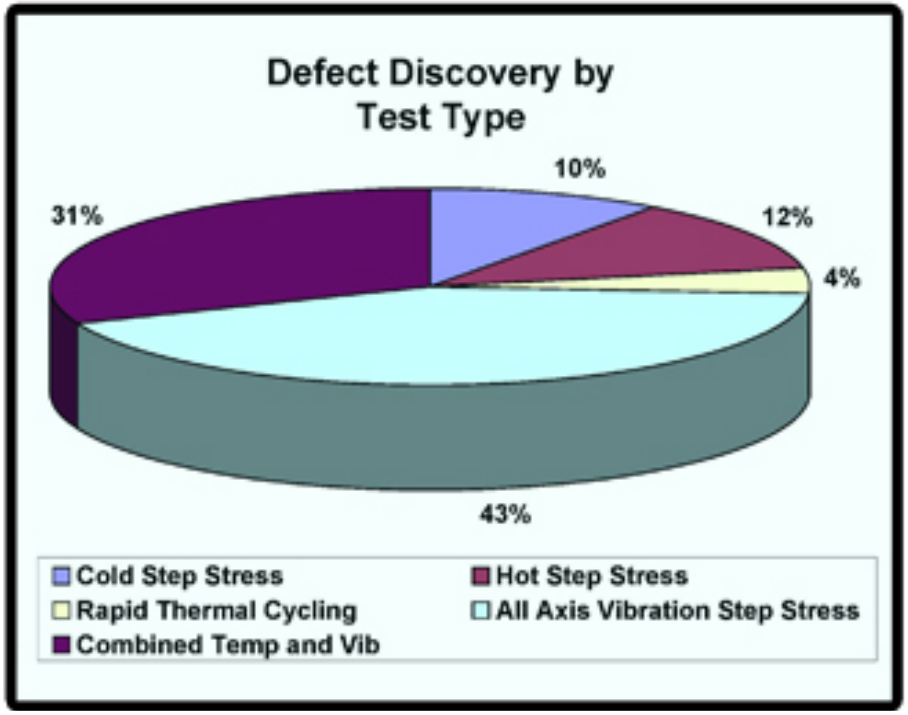
- Can detect failures with small number of samples (~4), very quickly (~ 1 week)
- Goal is to improve lifetime of device under routine operation



HALT

Typical discovery of defects due to different stresses





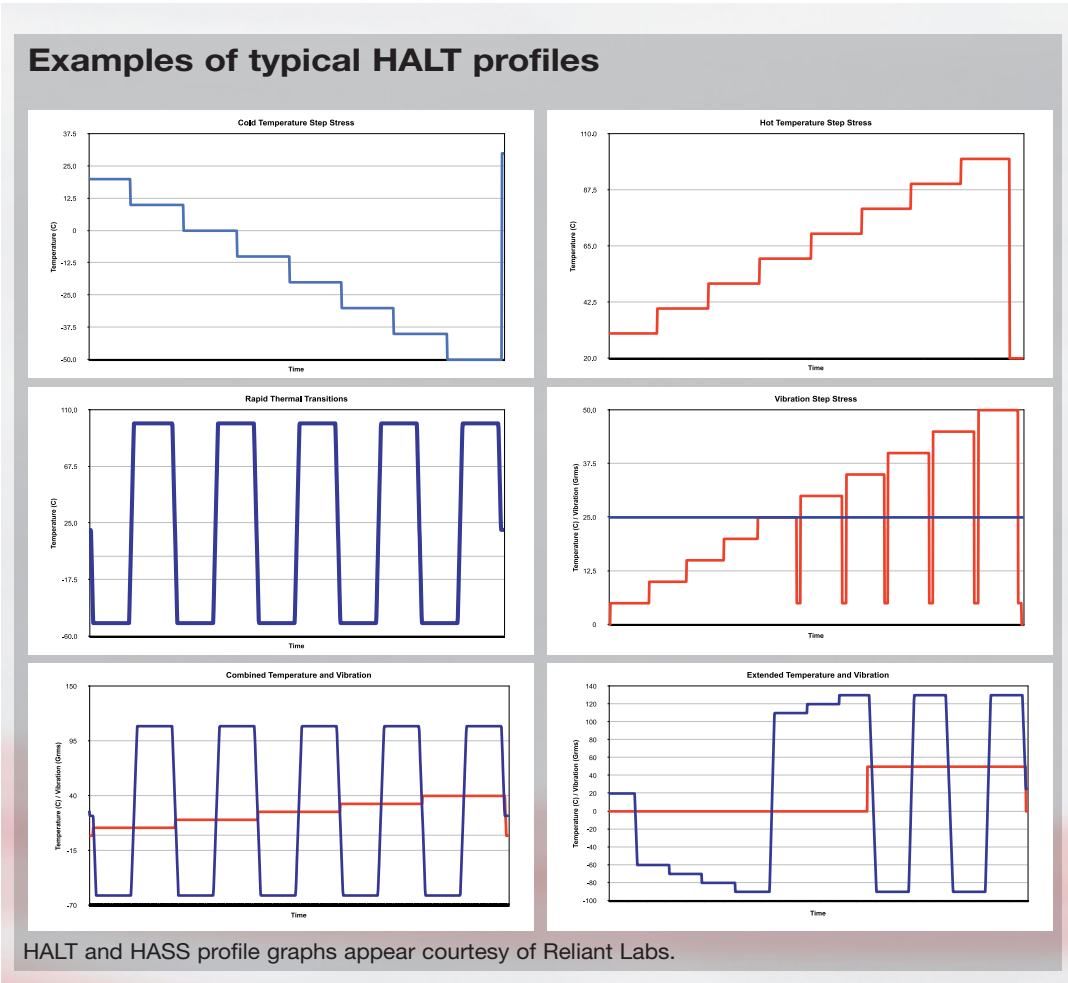
HALT

Cold or Hot step stresses in 10 C steps

5 thermal cycles with thermal changes of 50 C per minute. (Thermal Shock)

Step stress vibration in 5 gRMS increments

Combination of thermal and vibration stresses



HALT and HASS profile graphs appear courtesy of Reliant Labs.

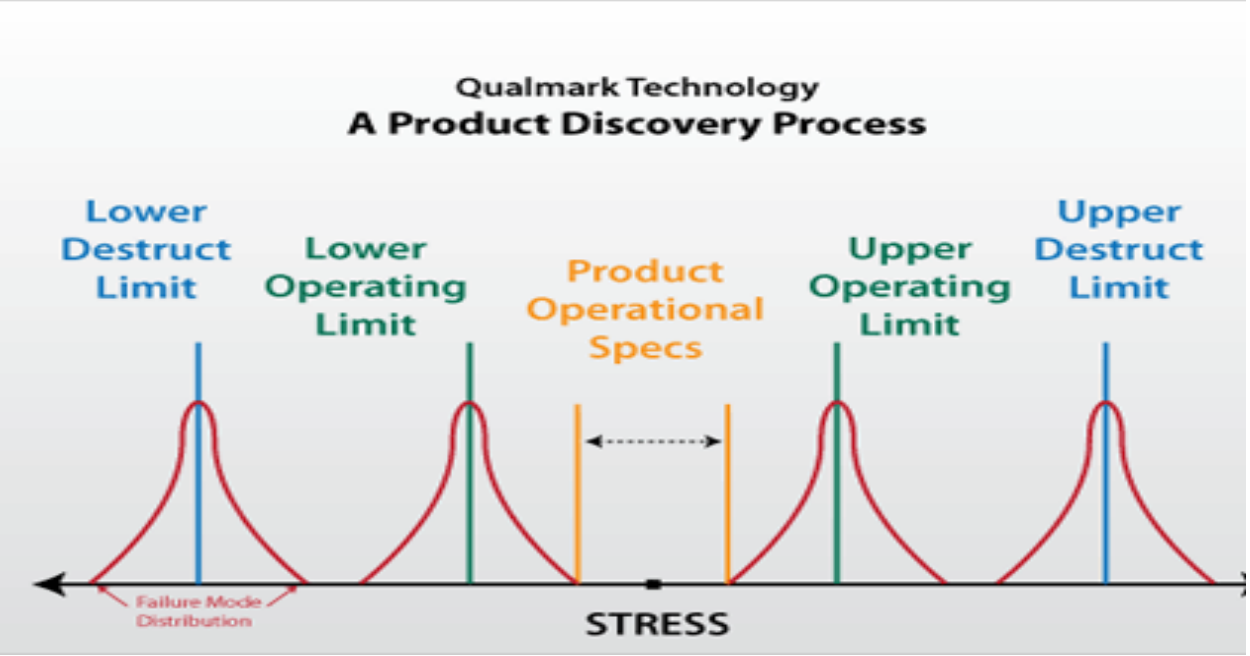
HALT

- When failure occurs, test is stopped and failure mode and stress level is recorded
- If fixable, temporary fix is implemented and test continues to higher stress levels to uncover more failures
- HALT testing stops when test equipment limits are met, multiple failures occur in rapid succession with small increases in the stress level, or when maximum level of the materials/ technology is reached

HALT

- Provides operating limits and may provide destruct limits
- Operational limits is defined as the stress necessary to cause a malfunction, but product returns to normal operation when stress removed
- Destruct limit causes permanent failure

HALT


Qualmark Technology
A Product Discovery Process
Lower Destruct Limit
Lower Operating Limit
Product Operational Specs
Upper Operating Limit
Upper Destruct Limit
Failure Mode Distribution
STRESS

HASS

- Post production process that can be performed on 100% of product or a partial sample
- Main goal is to precipitate and detect hidden or latent failures
- Verify products in production
- Stress levels less than those in HALT
- More severe than anticipated in actual service
- Use enough stress to find faults, but not enough to remove a significant amount of product's lifetime
- Pass/fail test

HASS benefits

- Precipitates hidden or latent failures caused by poor manufacturing process
- Verifies integrity of mechanical components
- Detects changes in components/processes
- Exposes process related variations in manufacturing

Some Energy Industry Customers

Some Electronics Customers

Aerospace

Honeywell

ASTRONICS CORPORATION

THALES

Astronautics Corporation of America

UNIVERSAL AVIONICS SYSTEMS CORPORATION

Defense

LOCKHEED MARTIN
We never forget who we're working for®

L3 communications

Raytheon

NORTHROP GRUMMAN
DEFINING THE FUTURE

BAE SYSTEMS

HARRIS

Medical

Medtronic

imagination at work

Baxter

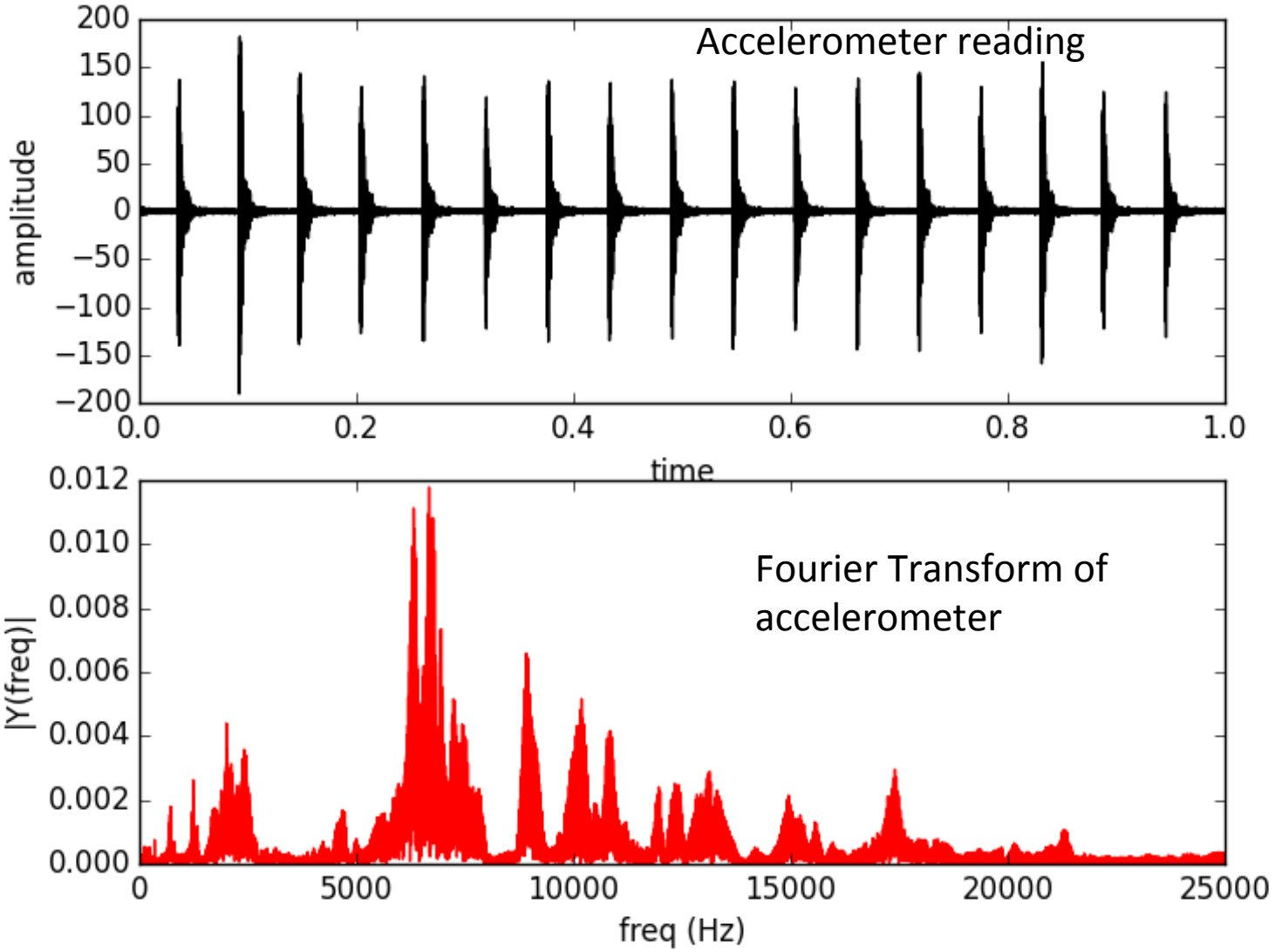
HALT HASS for pixels

- Proposal is to perform HALT/HASS on pixel modules to ensure they operate properly during the lifetime of the experiment
- Never been implemented in HEP experiments before but due to complexity of detectors and inability to access pixel detector it is imperative that all designs/components meet specifications
- HALT/HASS is an inexpensive and time effective method to help ensure robustness of detector design
- Commercial HALT/HASS systems cost ~ $65K-$100K for a small system.
- Need 1 HALT system, but will need many HASS systems if wishing to test all production modules prior to installation
- Therefore we are building our own HALT/HASS system at OU

OU HALT system

- Environmental chamber with a temperature range of -50 C -150 C. We are able to control chamber with a GUI to provide the necessary temperature stepping
- Vibration table. Single pneumatic hammer currently implemented provides a range of gRMS from 10-80 gRMS.
- Readout consisting of 3 accelerometers to measure x,y,z acceleration up to 50Khz
- Jig to hold module

Some initial plots from OU system



Under development

- gRMS controlled by air pressure/flow. Currently writing code to control air pressure/ flow using computer controlled air regulator to precisely control gRMS
- Adding in additional pneumatic actuators to allow more control over vibrations
- Module Readout: Investigating USBPIX